Report on the integration process and testing, evaluation and calibration methodologies and results

Deliverable 6.1.1

Anova IT Consulting

MOSIPS MODELING AND SIMULATION OF THE IMPACT OF PUBLIC POLICIES ON SMES

SEVENTH FRAMEWORK PROGRAMME

Modeling and Simulation of the Impact of public Policies on SMEs

ICT-2011.5.6 - ICT Solutions for governance and policy modeling

D6.1.1– Report on the integration process and testing, evaluation and calibration methodologies and results

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The project consortium is composed by: Anova IT Consulting (ANOVA), Universidad de Alcalá (UAH), Research Studio Austria Forschungsgesellschaft (RSA), University of Reading (UoR), TopNetwork (TOPN), University of Konstanz (Konstanz), European Institute of Interdisciplinary Research (EIIR), Ayuntamiento de Madrid (MUNIMADRID) and Comune di Verona (VERONA).

More Information

Public MOSIPS reports and other information pertaining to the project are available through MOSIPS public website under www.mosips.eu

Table of contents

List of Figures

1. Introduction

This deliverable document (D6.1 "Report on the integration process, and testing, evaluation and calibration methodologies and results") reports the preparatory activities performed by the project consortium in order to establish the bases of how the integration process, the testing, evaluation and calibration will be performed by the project consortium.

An overview of how the integration of the different software modules that compose the overall MOSIPS solution is provided in Section 2.

In Section 3 the methodologies foreseen for the testing of the system are presented, including the activities for the technical validation, the activities for the validation with the system end users and the foreseen use cases.

Section 4 presents the strategy that will be undertaken in order to proceed with the system calibration and validation.

2. MOSIPS Integration process

Systems integration aims at producing a single working system starting from separate components. This is not an easy task, as it is like building a clock: each component must be perfectly built and tested in isolation but should also be able to communicate with other components, transmitting the required information at the right time according to the defined architecture. All the components must be perfectly intersected like clock's gears.

The process follows a step-by-step integration methodology to facilitate early identification and solution of integration problems. This process aims at mitigating the risk by solving the major technical issues at an early stage.

The integration process comprises:

1. Identification and definition of the communication interfaces
2. Point-to-point integration tests
3. Multi-point integration tests
4. Final system scenarios tests

2.1 Identification and definition of the communication interfaces

The overall architecture of MOSIPS requires integration between the SFE component developed by the University of Reading, the geo-spatial component developed by RSA and the visual analytics developed by Konstanz University.

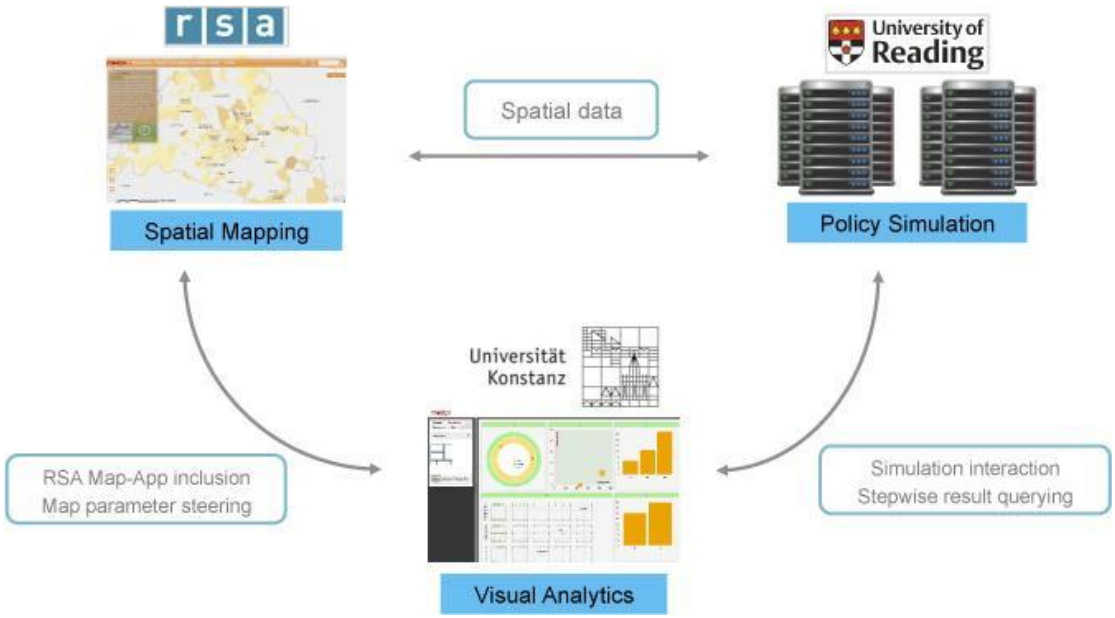

Figure 1: MOSIPS High-level system architecture

Figure 1 presents the high-level system architecture of MOSIPS and the connection between the different blocks of the system. The visual analytics module will constitute the interaction point with the end user.

The visual analytics module offers a workflow to the policy makers: within this process, the policy maker designs the policies he/she wants to explore. This is the starting point for the simulation and forecast engine: all necessary parameters are transferred to the simulator and the simulation is initiated. The SFE operates cycle wise: in the moment in which one cycle is ended, the visual analytics component retrieves first results and processes them. In the case of the geo-spatial component, due to the information processing necessity (the spatial mapping requires a fixed geo-spatial structure in order to create representative geo-representation), the visualization is possible only after the simulation process is complete (all the simulation cycles has been executed).

2.2 Integration preliminaries

As indicated in the previous section, there are several testing steps to be executed prior to the integration of the whole system. The first step is to test single communication interfaces with point-to-point integration tests. As indicated, MOSIPS will count with three communication interfaces: visual analytics interface with the SFE, visual analytics interfaces with the geo-spatial component and SFE with the geo-spatial component, therefore three point-to-point integration tests are needed.

According to the overall architecture of the MOSIPS system (the SFE component is hosted in Reading University, the Visual Analytics component is hosted in Konstanz University and the geo-spatial component is hosted in RSA premises), these tests will be executed by establishing a communication link between the labs of the partners developing each component. Subsequent integration steps, multi-point integration tests as well as the final system scenarios tests will be also executed based on this communication link.

2.3 Software components for integration

This section contains a brief description of the software components that will be integrated in order to produce the overall MOSIPS system.

2.3.1 Simulation and forecast engine

The simulation and forecast engine (SFE) is the software component in charge of carrying out the tasks of implementing the model in terms of running code and simulating the model to find out how the system variables evolve over time. The simulation system is composed by agents, their properties, behaviours, rules, system policies and the time period over which the simulation should take place for forecasting. SFE is responsible for simulating the agents and for evolving the variables of the system over time. The simulation results are stored in a database in each simulation cycle in order to provide visualisation of the forecast data and to provide open access to this data. For more detailed information on the Simulation and Forecast engine component please refer to the document D4.1 "MOSIPS SFE Module".

2.3.2 Visual analytics interface

The visual analytics interface for MOSIPS will constitute the main interaction point for the system. Through it, the policy maker will have the opportunity to create a

new policy simulation: the policy will be translated to a set of input variables, the opportunity to run the simulation that is based on an economic model will be given and results will be visualized providing the opportunity to interactively explore them using different visualizations. The results will be visualized incrementally, as soon as the SFE completes a cycle run, i.e. a 3-month-period, as defined by the policy makers.

2.3.3 Geo-spatial component

The geo-spatial component of the MOSIPS system is basically a Geographic Information System (GIS) that visualizes the results of the simulation and forecast engine in a geography based or map based graphical way. Generally a GIS is a specific information system that is designed to capture, store, manipulate, analyze, manage and present all types of geographical data. Due to the fact that the MOSIPS results and agent-based simulation techniques make use of the spatial domain it is obvious that the results should be presented in a spatial manner. In addition, any visualization that utilizes the map metaphor is easily conceivable by non-experts. Thus, citizens, political advisors and politicians themselves can be provided with easy-to-understand and easy-to-use applications. For more detailed information on the geo-spatial component, please refer to the document D5.1 "Visual analysis, interaction and social network component".

3. Testing process

This section of the document provide a description of the testing methodologies that will be followed by the MOSIPS consortium in order to validate the project outcomes from the technical point of view and from the end users point of view.

3.1 Technical validation

In order to test the behaviour of the overall MOSIPS system in terms of technical functionalities, the project consortium will implement a strategy based on module tests. Within the project framework, the module test is a test that describes how certain modules work regarding their functionality. The module test will describe the following functionalities:

General functionalities:

- Login into the MOSIPS system
- Toggle Sidebar in order to hide the control panel and visualize the simulation results in full screen
- Enter into the Simulation section in order to launch a new simulation
- Enter into the Visualization section in order to visualize the results of pre-computed simulations
- Switch between Simulation Section and Visualization Section

Simulation related functionalities:

- New Simulation Project:
  - Initiate a new Project
  - Choose a Country
  - Choose a SBA Principle
  - Create new Scenario
  - Run Simulation
- Existing Simulation Project:
  - Browse Project List
  - Open Existing Project
  - Edit Scenario
  - Delete Scenario
  - Edit Existing Project

Visual Analytics related functionalities:

- Refresh Project List
- Load Project for Visualization
- Select Result Table
- Start Result Retrieval
- Interrupt Result Retrieval
- Initiate Visualization Mapping via Drag & Drop
- Start Visualization
- Adapt Result Retrieval Interval
- Change Visualization
- Change Visualization mapping

- Open Visualization in Geo Analytics Module
- VA – Adapt Policy Parameters and Rerun Simulation

Geo-analytics related functionalities:

- Access to the Geo-Portal without scenario parameters
- Access to the Geo-Portal from the Visual Analytics
- Choose Country
- Choose scenario
- Check Scenario Settings
- Choose Statistics
- Change to visualization parameters window
- Tuning the visualization parameters
- Go back to the country, scenario and statistics selection window
- Run visualization on map
- Activate progressive visualization
- Control the zoom level of the map
- Open the settings lateral menu
- Show/Hide Info, Map set-up and legend windows
- Change map visualization type
- Open Share dialog
- Open Share dialog
- Give feedback to the policy makers

Each test result will be summarized in terms of:

- Function name
- Function goal
- Precondition
- Postcondition
- Actor
- Normal process
- Special cases

Name	Login
Goal	User logs in into the system
Precondition	- The user is not logged in.
Postcondition	- The user is logged in according to his user name and password and retrieves personalized information.
Actor	User / Policy Maker
Normal Process	1. The user types in username and password into the corresponding text fields. 2. The user either clicks on the button Login or confirms by clicking "Enter" on the keyboard.
Special Cases	1a User name or Password are not correct. 1a.1 Corresponding error message is shown and the user is asked to try again. 2a User name or Password are left empty. 2a.1 Corresponding error message is shown and the user is asked to try again.

Figure 2: Example of module test summary

3.2 MOSIPS end-users validation framework

The following framework, outlined in Figure 3, has been prepared for the overall validation of MOSIPS system by end users. Each element of this validation framework and approach are explained in the following paragraphs.

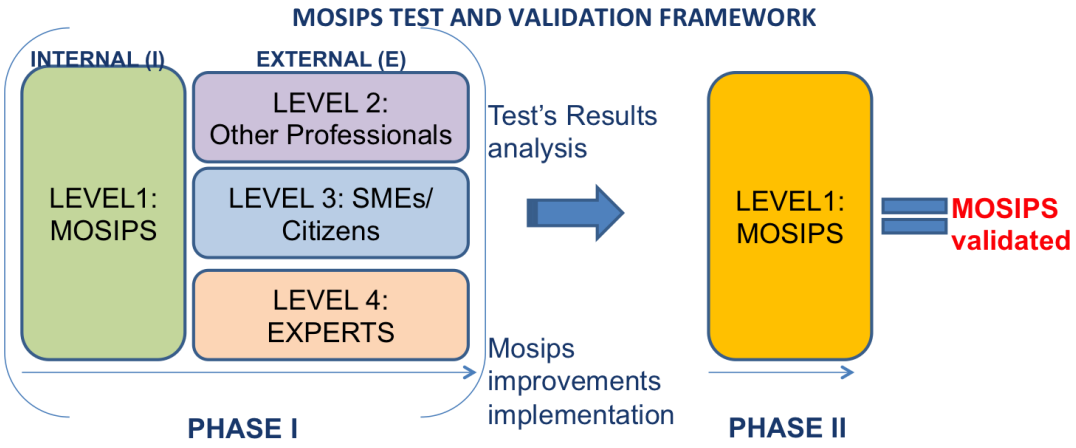

Figure 3: MOSIPS test and validation framework

MOSIPS will count with 2 different phases of validation:

PHASE I: Multilevel complex validation

During Phase I the MOSIPS solution will be widely tested against the criteria that will be defined as KPIs provided in D6.1.2. This phase will be divided into two distinct layers, depending on different types of users, organized around *internal* and *external layers*, which are further grouped into four different levels.

Internal layer (I) – the MOSIPS solution will be tested by the internal MOSIPS users who participated in the MOSIPS system definition and who are members of the MOSIPS consortium. Here Level 1 will be implemented.

LEVEL 1: MOSIPS – this level is the most detailed one and the highest number of efforts and remarks collected is expected.

a) WHO: MOSIPS consortium, professional users (Municipality of Madrid, City of Verona);
b) WHAT: Full MOSIPS features validation for the City of Verona and the Municipality of Madrid;
c) WHERE: Two different testbeds, Madrid and Verona, with data provided by the two end users.

External layer (E) – this testing phase will involve wider communities that were partially or not involved in shaping of the MOSIPS system. Three different levels are foreseen here:

LEVEL 2: OTHER PROFESSIONALS – this level will count on the participation of the cities involved in the EU funded PEOPLE project.

a) WHO: City of Bilbao and the Municipality of Thermi (Thessaloniki)
b) WHAT: Selected MOSIPS features validation
c) WHERE: The testbed for the city of Madrid will be used in this validation

LEVEL 3: LEVEL 3: SMEs/Citizens/Others – this level will provide feedback from the social network collaboration channel. At this level, the consortium will test the interface with the public audience, the dynamics of interaction with the policy makers and the overall approach of people in using this kind of tool to raise awareness of the results of policy implementation.

a) WHO: SMEs owners (citizens), members of SMEs associations, regular citizens who are gathered in social networks like Facebook.
b) WHAT: Selected MOSIPS features, social network component developed for capturing public audience qualitative feedback on proposed measures
c) WHERE: The testbed for the city of Madrid will be used in this validation

LEVEL 4: EXPERTS – this level will provide high-level expertise to be applied in the future development of the MOSIPS system. At this level the remarks which will shape the future lines of development of the system will be collected with the final aim of making it more interoperable and applicable to different groups of policy makers and sectors.

a) WHO: MOSIPS Experts Group
b) WHAT: Full MOSIPS features validation
c) WHERE: The testbed for the city of Madrid will be used in this validation

PHASE II: Validation of selected, improved functionalities

During Phase II **only critical features that have been improved** following the analysis of Phase I will be validated by the MOSIPS users (Level 1). This approach

will enable the consortium to validate whether the remarks have been implemented correctly and, at the same time, will allow reducing the overall test costs and required efforts.

3.2.1 Collecting results from validation-end user validation survey

In order to guarantee a smooth collection of the different validation results, as well as to obtain comparable information, each tester will be provided with a Validation Survey where he/she will be able to evaluate the results in terms of relevant validation criteria and provide his/her comments on the system performance as well as suggestions for possible improvements.

The Validation Survey will be attached in D6.1.2

3.2.2 Timeline of the validation framework implementation

In Figure 4 the schedule for the implementation of the different validation phases and levels is presented.

START Date: NOV_13(M39)
END Date: FEB_14(M42)

		M39				M40				M41				M42			
		W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
PHASE I																	
	LEVEL 1																
	LEVEL2																
	LEVEL 3																
	LEVEL 4																
	COLLECTING THE RESULTS AND ANALYSIS																
	MILESTONE:PHASE 1 COMPLETED!															!	
IMPLEMENTING CORRECTION IN MOSIPS																	
PHASE II																	
	LEVEL 1																
	COLLECTING THE RESULTS AND ANALYSIS																
	MILESTONE:PHASE 2 COMPLETED!																!

Figure 4: Timeline of the MOSIPS validation framework implementation

3.2.3 Testers (users' group)

In order to provide a comprehensive validation of the MOSIPS system, the consortium will involve a broad variety of types of users. The following section provides a brief description of each category of users that are foreseen to take part in the validation process.

3.2.3.1 Level 1: MOSIPS' users

As per the Internal Level 1, the two MOSIPS consortium end users (City of Madrid and Municipality of Verona) will lead the overall system validation process. These partners have actively contributed to the development of the system requirements and design and provided source data for testing the MOSIPS system. They will represent the professional users of the system and therefore are expected to generate the highest number of remarks that will be collected in order to ensure a high level of usability of MOSIPS by other potential policy-making bodies in public administrations. The profiles of the MOSIPS system users have been provided in D1.1 "MOSIPS system requirements & design".

3.2.3.2 Level 2: Other professionals

To ensure a more comprehensive validation by professional users, two additional municipalities have been invited to take part to the testing of the system. These are the City of Bilbao (Spain) and the Municipality of Thermi (Greece). These two cities have been also invited to provide their expectations regarding functionalities of the MOSIPS system (collected under D1.1 "MOSIPS system requirements and design") so their participation is a natural consequence of checking how far MOSIPS could support the needs of wider community of public administration policy-making bodies. However, the two entities have not participated in detailed discussions on the system design and integration so they will have a fresh, external view on what has been proposed as a standard in tools supporting policy modelling in Europe.

However this level is important to MOSIPS as it is based on fully volunteer participation. So we have this level as option depending on the availability of the other cities.

3.2.3.3 Level 3: Citizens and SMEs testers

In the framework of the MOSIPS system, there are specific features and interfaces foreseen in order to support the interaction between policy makers and society in general. Even if this is not a major functionality of the overall development, this has been considered as an important part for further development. Therefore, special efforts and attention will be paid to test this part of MOSIPS in natural conditions and with broader societal participation. The overall objective is to involve mainly citizens and SMEs owners of the regions in which MOSIPS pilots will take place (Madrid and Verona) so that the results of testing could answer how the solution is seen by both stakeholders involved: policy makers and citizens/SMEs at the same regional and cultural context.

Citizens and SMEs will be invited to access and provide their feedback via the developed Facebook APP. The participation of SMEs will be stimulated by the Stakeholders Engagement Strategy described in the document D7.1 "Plan for the dissemination of knowledge".

3.2.3.4 Level 4: Experts Group Perspective

Finally the MOSIPS Experts Group will be asked to provide their feedback and comments on the MOSIPS system in order to define further lines of MOSIPS development and make it more interoperable at different levels of the policy-making process. The group will be asked to look, test, and comment on the presented solution mainly during the final meeting foreseen for this consultation body.

3.2.4 MOSIPS Test Beds

In order to validate the technologies developed, two different testbeds will be realised for the City of Madrid and the City of Verona. Both testbeds will be used in order to collect the feedback from the different levels of validation foreseen by the framework presented in the previous sections. The testbed of Madrid will be used as the main validation test bed for Experts Group.

3.2.4.1 Technicalities of the test beds preparation

The technical group of the MOSIPS consortium will prepare the test the simulation environment in advance to provide a unified, stable condition in which the end users will be able to validate the system functionalities.

The main user interface will be available at the URL: http://mosips.dbvis.de/mosips and this will constitute the entry point for enabling policy makers setting up their simulation environments and visualize the obtained results.

The detailed practical instruction presenting how to use the system and its basic functions will be provided (user instruction attached in D6.1.2).

The technical support assistance will be provided by MOSIPS developers to the end users (communication centralized by the Project Coordinator) during the entire period of system validation.

3.2.5 Use cases description

In order to develop and validate the total functionality provided by MOSIPS, 6 use cases have been developed. The use cases are the follow-up of the User Requirements collected under the activities of WP1 (a specific User requirements questionnaire template was used at this aim) and structured in the document D1.1 "MOSIPS System requirements and design", as well as compromises between the availability and structure of possible test data available in Madrid and Verona.

The MOSIPS project takes the Small Business Act (SBA) http://ec.europa.eu/enterprise/policies/sme/small-business-act as the core area for policy investigation, analysis and modelling. The SBA forms the 'enabling framework' of the EU for improved SME performance and policy quality. It is the EU flagship SME policy initiative comprising ten principles that should guide the design and implementation of policies in the EU and its Member States. These principles have been identified as central to the conceptual, theoretical and empirical scope of MOSIPS.

The SBA "aims to improve the overall policy approach to entrepreneurship, to irreversibly anchor the "Think Small First" principle in policy making from regulation to public service, and to promote SMEs' growth by helping them tackle the remaining problems which hamper their development". It builds on the Commission's and Member States' policy achievements, creates a new policy framework that integrates the existing enterprise policy instruments, and builds in particular on the European Charter for Small Enterprises and the Modern SME policy. To implement this ambitious policy agenda, the Commission is proposing a genuine political partnership between the EU and Member States that respects the principles of "subsidiarity" and "proportionality".

The symbolic name of an 'Act' given to this initiative underlines the political will to recognize the central role of SMEs in the EU economy and to put in place for the first time a comprehensive policy framework for the EU and its Member States through a set of 10 principles to guide the conception and implementation of policies both at EU and Member State level. These principles – the programmatic and operational details outlined in general further in the text – are essential to

bring added value at EU level. They create a level playing field for SMEs across the EU and improve the, policy, legal, regulatory and administrative environment in which they operate.

These principles are as follows:

1. Create an environment in which entrepreneurs and family businesses can thrive and entrepreneurship is rewarded (ENTREPRENEURSHIP)
2. Ensure that honest entrepreneurs who have faced bankruptcy quickly get a second chance (SECOND CHANCE)
3. Design rules according to the "Think Small First" principle (THINK SMALL FIRST)
4. Make public administrations responsive to SMEs' needs (RESPONSIVE ADMINISTRATION)
5. Adapt public policy tools to SME needs: facilitate SMEs' participation in public procurement and better use State Aid possibilities for SMEs (STATE AID & PUBLIC PROCUREMENT)
6. Facilitate SMEs' access to finance and develop a legal and business environment supportive to timely payments in commercial transactions (ACCESS TO FINANCE)
7. Help SMEs to benefit more from the opportunities offered by the Single Market (SINGLE MARKET)
8. Promote the upgrading of skills in SMEs and all forms of innovation (SKILLS AND INNOVATION)
9. Enable SMEs to turn environmental challenges into opportunities (ENVIRONMENT)
10. Encourage and support SMEs to benefit from the growth of markets (INTERNATIONALIZATION)

As an outcome of the WP1 activities, the consortium end users (cities of Madrid and Verona) as well as the other professionals identified in the description of the MOSIPS validation framework Level 2, identified the following 4 European SBA action areas as the most important for their political activities: Entrepreneurship, Responsible Administration, Innovation and Environment.

Below the details for each one of the identified and developed use cases is presented.

3.2.5.1 Use case 1: Entrepreneurship – Training courses for promoting entrepreneurship

The development of this use case arose from a specific necessity of the project end users Madrid and Verona (necessity shared also by the other stakeholders interviewed in the framework of WP1): increase the municipality GDP through the creation of new companies.

This typology of policy action can be perfectly framed in the context of the first SBA principle, **Entrepreneurship**. In fact, according to this principle, the EU and Member States should create an environment within which entrepreneurs and family businesses can thrive and entrepreneurship is rewarded. They need to care for future entrepreneurs better, in particular by fostering entrepreneurial interest

and talent, particularly among young people and women, and by simplifying the conditions for business transfers.

To translate this principle into practice, the Commission:

- Is promoting entrepreneurial culture and facilitating exchanges of best practice in enterprise education
- Has launched a "European SME Week" in 2009 — an umbrella for many campaign-type events that will take place throughout Europe
- Has launched the "Erasmus for Young Entrepreneurs" initiative in 2008, which aims to promote exchanges of experience and training by giving nascent entrepreneurs the possibility to learn from experienced host entrepreneurs and improve their language skills
- Will establish an EU network of female entrepreneur ambassadors, promote mentoring schemes to inspire women to set up their own businesses and promote entrepreneurship among women graduates.

The Member States are invited to:

- Stimulate innovative and entrepreneurial mind-sets among young people by introducing entrepreneurship as a key competence in school curricula, particularly in general secondary education, and ensure that it is correctly reflected in teaching material
- Ensure that the importance of entrepreneurship is correctly reflected in teacher training
- Step up cooperation with the business community in order to develop systematic strategies for entrepreneurship education at all levels
- Ensure that taxation (in particular gift tax, taxation of dividends and wealth tax) does not unduly hamper the transfer of businesses
- Put in place schemes for matching transferable businesses with potential new owners
- Provide mentoring and support for business transfers
- Provide mentoring and support for female entrepreneurs
- Provide mentoring and support for immigrants who wish to become entrepreneurs.

In line with the invitation for the Member States to provide mentoring support for business creation and entrepreneurship, a specific use cases covering this opportunity has been created.

USE CASE 1	Training courses for promoting entrepreneurship	
SBA Area	Entrepreneurship	
Policy action	Training courses for promoting entrepreneurship	
Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application

	City districts in which the policy will be applied	This design parameter allows specifying the city districts that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Available budget	This design parameter allows specifying the available budget that promoting entity can allocate to the execution of the policy design
	Number of beneficiaries	This design parameter allows specifying the number of individuals that will be able to benefit the policy design.
	Beneficiaries age range	This design parameter allows specifying the age range to which beneficiaries have to belong to (i.e. only young people or all working ages)
	Beneficiaries gender	This design parameter allows specifying the beneficiaries gender (i.e. establishment of a policy action specifically aimed to promote female entrepreneurship)
	Beneficiaries labour status	This design parameter allows specifying the beneficiaries labour status (i.e. only for unemployed people)
	Long-term unemployment	This design parameter allows specifying if the policy design beneficiaries should be long-term unemployed or not.
	Beneficiaries education level	This design parameter allows specifying the education level of the policy beneficiaries (no studies, primary education, secondary education, basic vocational training, advanced vocational training, pre university studies, university degree, master/PhD)
Main positive effects indicators to be monitored	Number of new companies created with the application of the training programme	
	GDP evolution in the city territory	

Main side effects indicators to be monitored	Diversity of entrepreneurs education level
	Diversity of the sectors to which new companies belongs to

3.2.5.2 Use case 2: Entrepreneurship – Provisioning of support for business incubation

Also in this case, the development of this use case arose from a specific necessity of the project end users Madrid and Verona: increase the municipality GDP through the creation of new companies.

In line with the Commission invitation to the Member States of providing mentoring and support for entrepreneurship, the possibility of forecasting the effects on the territory due to the provisioning of support for business incubation has been created.

USE CASE 2	Provisioning of support for business incubation	
SBA Area	Entrepreneurship	
Policy action	Provisioning of support for business incubation	
Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application
	City districts in which the policy will be applied	This design parameter allows specifying the city districts that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Available budget	This design parameter allows specifying the available budget that promoting entity can allocate to the execution of the policy design
	Incubation time	This design parameter allows specifying the timelaps in which the companies will benefit for the incubation time
	Beneficiaries age range	This design parameter allows specifying the age range to which beneficiaries have to belong to (i.e. only young people or all working ages)

	Beneficiaries business sectors	This design parameter allows specifying the beneficiaries business sector (i.e. policy action aimed only for IT companies)
Main positive effects indicators to be monitored	Number of new companies created with the application of the incubation programme	
	GDP evolution in the city territory	
Main side effects indicators to be monitored	Evolution of the same typology of companies turnover in districts adjacent to the one that is benefitting of the policy design	
	Diversity of the sectors to which new companies belongs to	

3.2.5.3 Use Case 3: Responsive administration – Reduce youth unemployment

The development of this use case arose from a specific necessity of the project end users Madrid and Verona (necessity shared also by the other stakeholders interviewed in the framework of WP1): increase employment rates for young people.

This typology of policy action can be perfectly framed in the context of the fourth SBA principle, **Responsive Administration**. In fact, according to this principle, the EU and Member States should make public administrations responsive to SME needs, making life as simple as possible for SMEs, notably by promoting e-Government and one-stop-shop solutions.

To translate this principle into practice:

The Member States are invited to:

- Reduce the level of fees requested by the Member States' administrations
- Continue to work to reduce the time required to set up a business to less than one week, where this has not yet been achieved
- Accelerate the start of SMEs' commercial operations by reducing and simplifying business licences and permits. More specifically, Member States could set a maximum deadline of 1 month for granting these licences and permits, except in cases justified by serious risks to people or the environment
- Refrain from asking SMEs for information which is already available within the administration, unless it needs to be updated
- Make sure that a micro-business is not asked to participate in a statistical survey under the responsibility of the state, regional or local statistical office more than once every three years, provided that the needs for statistical and other types of information do not require otherwise establish a contact point to which stakeholders can communicate rules or procedures which are considered to be disproportionate and/or unnecessarily hinder SME activities
- Ensure full and timely implementation of the Services Directive, including the setting up of points of single contact, through which businesses can obtain all relevant information and complete all necessary procedures and formalities by electronic means.

In line with the invitation for the Member States to reducing the level of fees requested, a specific use cases covering this opportunity has been created.

USE CASE 3	Reduce youth unemployment	
SBA Area	Responsive administration	
Policy action	Tax reduction for hiring young employees	
Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application
	City districts in which the policy will be applied	This design parameter allows specifying the city districts that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Percentage of tax reduction for hiring young employees	This design parameter allows specifying the percentage of tax reduction for hiring young employees (it can vary between 0% until 100%)
	Beneficiaries age range	This design parameter allows specifying the age range to which beneficiaries have to belong to
	Beneficiaries business sectors	This design parameter allows specifying the beneficiaries business sector (i.e. policy action aimed only for IT companies)
	Beneficiaries maximum number of employees	This design parameter allows specifying the maximum size of the beneficiary company
	Bonus period	This design parameter allows specifying for how many quarters the company will benefit of the tax reduction
Main positive effects indicators to be monitored	Evolution of the employment rates for young people (age range: 16 – 30)	
	Evolution of the employment rates for the business sector beneficiary of the public policy	
Main side effects indicators to be monitored	Evolution of the employment rates for people in the 31 – 45 and 46 - 65 age range	
	Evolution of the employment rates for the business sectors that are not beneficiary of the public policy	

3.2.5.4 Use Case 4: Responsive Administration – Reduce long-term unemployment

Also in this case, the development of this use case arose from a specific necessity of the project end users Madrid and Verona: decrease the long-term unemployment rates[1] that constitutes an important social problem for the city.

In line with the Commission invitation to the Member States of reducing the fees level, the use case is based on the possibility that municipalities have of reducing property tax for stimulating the hiring of long-term unemployed.

USE CASE 4	Reduce long-term unemployment	
SBA Area	Responsive administration	
Policy action	Tax reduction for hiring long-term unemployed	
Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application
	City districts in which the policy will be applied	This design parameter allows specifying the city districts that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Percentage of tax reduction for hiring long-term unemployed	This design parameter allows specifying the percentage of tax reduction for hiring long-term unemployed (it can vary between 0% until 100%)
	Beneficiaries business sectors	This design parameter allows specifying the beneficiaries business sector (i.e. policy action aimed only for IT companies)
	Beneficiaries maximum number of employees	This design parameter allows specifying the maximum size of the beneficiary company
	Bonus period	This design parameter allows specifying for how many quarters the company will benefit of the tax reduction

[1] Long-term unemployment is defined as referring to people who have been unemployed for 12 months or more. The ratios calculated here show the proportion of these long-term unemployed among all unemployed, hereafter called long-term unemployment rates. Lower duration limits (*e.g.* six months or more) are sometimes considered in national statistics on the subject. http://www.oecd-ilibrary.org/sites/factbook-2013-en/07/02/02/index.html?itemId=/content/chapter/factbook-2013-58-en

Main positive effects indicators to be monitored	Evolution of the employment rates in the city territory
	GDP evolution in the city territory
Main side effects indicators to be monitored	Unemployment rates for youth people
	Unemployment rates for non beneficiary business sectors

3.2.5.5 Use Case 5: Innovation – Foster internal R&D in firms that currently innovate

According to the eighth SBA principle, the EU and Member States should promote the upgrading of skills in SMEs and all forms of innovation. They should encourage investment in research by SMEs and their participation in R&D support programmes, transnational research, clustering and active intellectual property management by SMEs.

To translate this principle into practice, the Commission:

- Has further extended a scheme to promote the mobility of apprentices as part of the Leonardo Da Vinci Programme for 2010
- Is supporting the development by stakeholders of an online e-Skills and Career Portal that enables firms to self-assess their e-skills needs and find out how to develop the careers and qualifications of their staff
- Will continue efforts through simplification, better information and higher financing rates to optimise SME-participation in the 7th RTD Framework Programme (FP7).
- Is encouraging the growth of SMEs, by ensuring that an SME participating in a FP7 project can keep the benefit of SME treatment for the whole duration of that project, even if it exceeds the SME ceilings during that period
- Will simplify State Aid rules for Member States to support research, development and innovation, notably through the General Block Exemption Regulation
- Is boosting the emergence of high growth enterprises by supporting the research and innovation capacity of SMEs, mainly through increased coordination of national programmes and initiatives
- Will, in consultation with Member States, develop a cluster strategy including initiatives to encourage transnational cluster cooperation, facilitating clusters' access to new markets and taking measures to encourage greater participation of SMEs in innovative clusters
- Will seek to support SME participation in knowledge transfer, partly through the launching of a pilot project to help fund the commercialisation of intellectual property
- Will encourage an active participation of SMEs in the framework of the activities carried out by the European Institute of Innovation and Technology (EIT), to enable them to benefit from the knowledge transfers fostered by the EIT. the Member States are invited to:
- Encourage the efforts of SMEs to internationalise and become high growth enterprises including through participation in innovative clusters

- Promote the development of SMEs' competences in the research and innovation field by means of, e.g. simplified access to public research infrastructure, use of R&D services, recruitment of skilled employees and training, as allowed for in the new Community Framework for State Aid for research, development and innovation
- Open up national research programmes where this is of mutual benefit to SMEs from other Member States and contribute to SMEs' access to trans-national research activities, e.g. through joint programming
- Ensure in their implementation of the Cohesion Policy programme an easy access of SMEs to funding related to entrepreneurship, innovation and knowledge
- Support the development of an electronic identity for businesses, to enable e-invoicing and e-government transactions
- Encourage business, in particular SMEs and other stakeholders, including procurement authorities, to participate in actions contributing to the speedy implementation of the Lead Market Initiative.

The Member States are invited to:

- Encourage the efforts of SMEs to internationalise and become high growth enterprises including through participation in innovative clusters
- Promote the development of SMEs' competences in the research and innovation field by means of, e.g. simplified access to public research infrastructure, use of R&D services, recruitment of skilled employees and training, as allowed for in the new Community Framework for State Aid for research, development and innovation
- Open up national research programmes where this is of mutual benefit to SMEs from other Member States and contribute to SMEs' access to trans-national research activities, e.g. through joint programming
- Ensure in their implementation of the Cohesion Policy programme an easy access of SMEs to funding related to entrepreneurship, innovation and knowledge
- Support the development of an electronic identity for businesses, to enable e-invoicing and e-government transactions encourage business, in particular SMEs and other stakeholders, including procurement authorities, to participate in actions contributing to the speedy implementation of the Lead Market Initiative.

In line with the Commission invitation to the Member States of promoting the development of SMEs' competences in the research and innovation field, the use case is based on the possibility that municipalities have for making available public grants for promoting R&D by hiring high skills employees.

USE CASE 5	Foster internal R&D in firms that currently innovate
SBA Area	Skills and innovation
Policy action	Public grants for promoting R&D through the hiring of high skills employee (tax reduction)

Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application
	City districts in which the policy will be applied	This design parameter allows specifying the city districts that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Available budget	This design parameter allows specifying the available budget for the policy design implementation
	Beneficiaries business sectors	This design parameter allows specifying the beneficiaries business sector (i.e. policy action aimed only for IT companies)
	Beneficiaries maximum number of employees	This design parameter allows specifying the maximum size of the beneficiary company
	Bonus period	This design parameter allows specifying for how many quarters the company will benefit of the tax reduction for the profile hired.
Main positive effects indicators to be monitored	Evolution of the SMEs innovation expenditure level	
	Increase of the turnover for the companies belonging to the business sector object of the policy design	
	Evolution of firms' R&D workforce	
Main side effects indicators to be monitored	Evolution of the turnover for the companies belonging to sectors not object of the policy design	
	Unemployment rates for citizens with lower education degree	

3.2.5.6 Use case 6: Environment – Oil products tax increase

According to the ninth SBA principle, the EU and Member States should enable SMEs to turn environmental challenges into opportunities. They should provide more information, expertise and financial incentives for full exploitation of the opportunities for new "green" markets and increased energy efficiency, partly through the implementation of environmental management systems in SMEs.

To translate this principle into practice:

The Commission:

- Is facilitating SMEs' access to the Eco-Audit and Management Scheme (EMAS) through lighter environmental procedures, reduced fees, and the option of cluster registration
- Will finance a network of environment and energy efficiency experts in the Enterprise Europe Network providing advice on eco-efficient operations, markets potential and funding opportunities for more efficient operations in particular for SMEs
- Is developing new forms of support for innovative start-ups and SMEs in the field of eco-innovation, with a view to facilitating market access, technology transfer, use of standards and access to finance, in line with existing State Aid provisions

The Member States are invited to:

- Provide incentives for eco-efficient businesses and products (e.g. tax incentive schemes and prioritising subsidies for funding sustainable business) in line with the Community Guidelines on State Aid for Environmental Protection and make use of the simplified approach to environmental aid for SMEs developed in the GBER
- Make full use of the around €2.5 billion allocated in Cohesion Policy programmes for the support of eco-friendly products and processes in SMEs.

As an indirect measure to spur the exploration of eco-efficient production schemes, a use case for providing the possibility of analysing the short-term impact of an increase of oil products taxation has been developed.

USE CASE 6	Oil products tax increase	
SBA Area	Environment	
Policy action	Oil products tax increase	
Policy design parameters	Region on which the policy will be applied	This design parameter allows specifying the region that will be object of the policy application
	Municipality in which the policy will be applied	This design parameter allows specifying the municipality that will be object of the policy application
	Policy design application time frame	This design parameter allows specifying: 1. The policy design application time frame 2. The analysis period covered by the simulation process (in order to analyse the policy effects after its implementation period)
	Oil products tax percentage increase	This design parameter allows specifying the tax percentage increase on oil products
	Beneficiaries business sectors	This design parameter allows specifying the beneficiaries business sector
Main	Evolution of the employment rate in the municipality	

indicators to be monitored	Evolution of the municipality GDP

4. Calibration and validation framework

This section of the report presents the methodologies and activities foreseen for the process of evaluation and calibration of the run-able MOSIPS model. Section 4.1 introduces the specifics of the MOSIPS calibration and validation process while section 4.2 introduces the definition of the project foreseen validation and calibration methodologies.

4.1 MOSIPS calibration and validation process

Agent-based modelling (ABM) is a powerful simulation modelling technique that, in the last few years, has been used in a high number of applications, including applications in economics. In ABM a system is modelled as a collection of agents (autonomous decision-making entities) that individually assess their situation and take decisions on the basis of a set of rules (agent behaviour). Agents can execute different behaviours (reactive or proactive) for the system they represent and can be used to replicate and extrapolate activities in some real-world domain such as social science, economics or political science.

The rapid growth of ABMs in economics has been supported by the following characteristics of this modelling technique:

1. Bottom-up perspective: ABMs allows overwhelming the limits imposed by the top-down nature of traditional neoclassical models, in which the bottom level is usually represented by a representative individual that is constrained by strict consistency requirements associated with equilibrium and hyper-rationality [1] . With their bottom-up perspective, ABMs are capable of describing the properties of macro-dynamics through the analysis of micro-dynamics involving basic entities. The aggregated properties emerge from repeated interactions between simple entities; they are not the results of rationality consistency and equilibrium requirements imposed by the modeller.
2. Heterogeneity: Agents allows representing heterogeneous characteristics, including different behavioural rules, competencies, initial conditions and rationality.
3. Bounded rationality: The environment in which real-world economics agents live is too complex for hyper-rationality to be a viable simplifying assumption [2]. ABMs allow assigning to agents some local and partial principles of rationality and agents are assumed to behave as boundedly rational entities with adaptive expectations.
4. Networked direct interactions: Interactions between economic agents in ABM are direct and inherently non-linear [3]. Agents are able to interact taking into account past choices taken by other agents in the population.

These characteristics enabled producing a simulation paradigm with a great potential for developing models with a high detail level and capable of describing difficult application areas. Thanks to the relatively easy possibility of establishing parallelisms between agents and the active elements in the original system object of the modelling process, ABMs have the potential of constituting the key for transforming modelling and simulation in a powerful research and analysis model for the economic domain.

4.2 Definition of the MOSIPS evaluation and calibration methodologies

One of the basic prerequisite for every simulation model is the validity. According to [4], validity means that the right model is used for the simulation process. A model that is valid enough, is able to produce reliable results and the answers derived from its simulation can be considered as correct for questions related with the original system. This introduces the concept of validation; validation is, according to [5], "the process of determining whether a simulation model is an accurate representation of the system, for the particular objectives of the study". Such as in any other simulation technique, validation is essential also for agent-based simulations; however in the case of the agent-based models, the bottom-up perspective intrinsic of this modelling technique should be taken into account.

Agent-based modelling contrasts with the traditional socio-economic models in which a top-down perspective is usually implemented (considering a representative individual/entity with strong consistency requirements and associated with equilibrium conditions). In agent-based modelling a bottom-up approach is implemented; this approach allows understanding the properties of macro-dynamics as outcome of micro-dynamics involving basing entities (heterogeneous agents that populate a complex system and that evolve through time). According to this, simulation results are represented by aggregated properties that are the result of repeated interactions among simple entities (in contrast with traditional socio-economic models in which these are the results of consistency, rationality and equilibrium requirements established by the modeller).

This characteristic, together with other elements such as a high number of assumptions or the over-parameterization of the model, can introduce a high level of complexity in the validation process of a multi-agent model. It is due to this that it is extremely important defining an appropriate procedure for validating the MOSIPS model.

A review of existing literature has been performed in order to perform this definition, taking into account some of the scientific papers with the highest impact (in terms of citations) among the scientific community.

[6] supported in the common definition of model errors and model uncertainty.

[7] constituted a guidance for a preliminary definition and classification of the errors that can appear in the process of developing an ABM.

The concept of "Ex-post validation" presented by [8] guided the consortium to perform validation processes on a run-able implementation using a reduced set of input data. [9]

Finally, taking as basis the outcomes of [10] , the project consortium has decided implementing a validation framework based on two different levels of validity: structural validity and behavioural validity. Structural validity refers to the validity of the internal structure of the model (the relations between variables and agents) while behavioural validity refers to the input-output behaviour of the overall system.

The choice of operating on these two levels is due to the fact that a highest level of validity is achievable when both techniques are successfully applied.

In the framework of the MOSIPS project, the structural validity of the model will be verified by implementing an approach of structural validation in combination with an empirical validation (process in which an agent based model has value of its coefficients in order to minimize the error with respect to data sources [1]); the behavioural validity of the model will be verified by implementing an approach of face validation in combination with the input of the project end users and external groups knowledge that provided their feedback on the plausibility of the simulation results obtained according to their knowledge and experience.

As per the structural validation, after having achieved a run-able model implemented in the SFE (Simulation and Forecast Engine Component), the consortium will follow the following steps in order to further check that the model could be considered as valid from a scientific point of view. In order to perform this analysis, the following information will be re-analysed taking into account the coding and the output of the run-able model version object of the study:

1. Re-analysis of the module rationale and alignment with the overall SFE behaviour;
2. Analysis of each module impact on the rest of the modules and output variable update in order to verify its correctness;
3. Enumeration of the principal objects present in the module;
4. Enumeration and analysis of the principal variables subject to changes/actualizations during the module execution;
5. Enumeration of the assumptions made in the theoretical model and analysis of the impact they had on the forecast obtained;
6. Analysis of the model mathematical form and monitoring of the perfect alignment between the theoretical and codified model.

In terms of behavioural activity, the project consortium will implement a structured process of empirical validation according to the following steps:

1. Implementation of the run-able model;
2. Execution of a process of face validation focusing on an Output Assessment (plausibility of the obtained values and trends of the different output values in the different simulation runs) aimed at checking the plausibility of the implemented model;
3. Implementation of a process of sensitivity analysis and calibration for establishing the model parameters in a way that the structurally correct model produces a valid outcome;
4. Iteration of the steps (2) and (3) aimed at obtaining a calibrated and deployable simulation model.

In this process, the complete compound of the simulator input and output variables will be considered as the object of the analysis.

The empirical validation process has been enriched by a process of face validation conducted with the cooperation of the two consortium end users (Municipalities of Madrid and Verona) and the involvement of the external experts belonging to the

MOSIPS Experts Group. A model that has face validity appears to be a reasonable imitation of a real-world system to people who are knowledgeable of the real world system [11]. In this case the object of the analysis will be a deployable version of the overall MOSIPS environment and, through structured walk-throughs, the implicit knowledge of the involved stakeholders will be collected in order to, both, get a feedback on the model validity and confirm the required degree of the solution usability and applicability to their own activities' scenario.

4.2.1 Structural validity

These steps will be the result of the adaptation to the specific MOSIPS characteristics of the concept of Structure Confirmation Test presented in [12]. The rationale behind the activities to be executed is constituted by the necessity of, at first, comparing the form of the mathematical equations presented in the model, analyse the way these equations have been codified and compare them with the relationships that exist in the real system (in the specific MOSIPS case with generalized socio-economic theories proceeding from the literature).

As described in D3.1 "Objects and objects' relationships models", MOSIPS has been developed as a modular agent-based model composed by 14 modules. These modules allow representing the dynamics of behaviours, interactions and decisions of the active participants. Under WP4, the mathematical model designed has been converted in a run-able model in which these active participants are created as agents of the simulation system and their properties are created as variables of the agents. The agents are created as C++ classes and the properties as internal variables of the agent classes. The behaviours of the agents are created as methods of the corresponding class and have been sequenced to form a flow of control sequences which form a single simulation run. Testing activities will be performed at level of each of the 14 activities presented in D4.1 "MOSIPS SFE module" in order to assess the impact of each one of them on the overall model behaviour and verify the implementation correctness. With this aim, tests involving simulations will be performed, implementing extreme-conditions scenarios (assignment of extreme values to selected parameters and comparing the model generated behaviour with the expected one) and behaviour sensitivity tests (identification of the parameters to which the model is highly sensitive and analysis on the sensitivity level of the same parameter in the real world).

4.2.2 Behavioural validity

As discussed in previous sections, the behavioural activity of MOSIPS has been studied by implementing a structured process of empirical validation.

A comprehensive review of current literature on empirical validation has been conducted, focusing on specific approaches for agent-based modelling. This study mainly focused on the "Indirect calibration approach" and the "Werker-Brenner Approach to Empirical Calibration".

According to [1] , the "Indirect calibration approach" is a pragmatic four-step approach to empirical validation. According to this approach, a model can be indirectly calibrated by first performing a validation and then, according to the results obtained, focusing on the parameters that are consistent with output

validation. This typology of process can be executed once a run-able model is available and by re-executing all the test scenarios after each parameters modification.

According to [13], the "Werker-Brenner approach" is a three-step procedure for empirical calibration in which existing empirical knowledge is used in order to calibrate initial conditions and the ranges of the model parameters. In a first step this knowledge is used in order to calibrate initial conditions, in a second step an empirical validation of the outputs for each of the model specification is performed and finally, in step three, an additional calibration is performed on the surviving set of models and, if helpful, takes into account expert testimony from historians.

In the framework of the MOSIPS project, a combination between these two approaches for behavioural validity will be implemented. Taking into account the availability of statistical information sources and results proceeding from literature, a first approach has been established based on the Werker-Brenner. Available information will be used in order to establish a first value for the model calibration coefficients and perform first simulations with the run-able SFE.

Once obtained the first results, the "Indirect calibration approach" will be used in order to validate the coefficients values used in a first attempt or fine-tune them if required.

5. Conclusions

This deliverable document presented the framework in which the MOSIPS consortium will proceed with the overall process for integrating, testing, evaluating and calibration the overall solution.

In Section 2 the overall integration process for connecting the three main components of the solution (Simulation and Forecast Engine, Visual Analytics component and geo-spatial component) has been presented, analyzing the specificities of having a geographically distributed solution.

Section 3 presented the activities foreseen in order to test the solution, both from a technical and end user point of view. A comprehensive description of the use cases that will be used for validation has been also presented.

In Section 4 the framework of the activities that will be executed for validating and calibrating the MOSIPS model has been presented, providing details on how the structural validity and the behavioral validity of the overall system will be tested.

6. REFERENCES

[1] P. Windrum, G. Fagiolo y A. Moneta, «Empirical validation of agent based models alternatives and propects,» *Journal of Artificial Societies and Social Simulation,* vol. 10(2), p. 8, 2007.

[2] Dossi et all, 2005.

[3] Fagiolo, 1998.

[4] Balci, «Validation, verification and testing techniquews throughout the life cycle of a simulattion study.,» *Annals of Operations Research..*

[5] A. M. Law, How to build valid and credible Simulation models. Proceedings of the 2005 Winter Simulation Conferences..

[6] J. Messina, T. Evans, S. M. Manson, A. M. Shortridge, P. J. Deadman y P. H. Verburg, «Complex systems models and the management of error and uncertainty,» *Journal of Land Use Science,* pp. 3(1), 11-25.

[7] J. M. Galán, L. R. Izquierdo, S. S. Izquierdo, J. I. Santos, R. Del Olmo, A. López-Paredes y B. Edmonds, «Errors and artefacts in agent-based modelling,» *Journal of Artificial Societies and Social Simulation ,* 2009.

[8] C. Bianchi, P. Cirillo, M. Gallegati y P. A. Vagliasindi, «Validating and calibrating agent-based models: a case study.,» *Computational Economics,* pp. 30(3), 245-264, 2007.

[9] P. Ormerod y B. Rosewell, «Validation and verification of agent-based models in the social sciences.,» 2009.

[10] F. Klügl, « A validation methodology for agent-based simulations.,» *In Proceedings of the 2008 ACM symposium on Applied computing ,* pp. 39-43, 2008.

[11] Carson y John, «MODEL VERIFICATION AND VALIDATION.,» *Proceedings of the 2002 Winter Simulation Conference.*

[12] Barlas, «Formal aspects of model validity and validation in system dynamics.».

[13] Fagiolo, Moneta y Windrum, «A critical guide to empirical validation of agent-based models in economics: methodologies, procedures and open problems.».